

Request for Research Funding for FY 2020-2021

Requesting Office	District 5	Priority	1 of 2 (projects may not have the same ranking – no ties)
Proposed Title	“Storm-Drone”: An autonomous UAV platform for post hurricane accurate damage assessment.		
Justification	<p>Describe the current situation, why the research is needed, and how the research affects your office’s mission critical focus areas</p> <p>After a hurricane event, the process of debris quantification and damage assessment is done manually, and the result is very subjective. Human operators estimate the quantity of debris and assess damage in order to start the process of clearing and repair/recovery.</p> <p>The current process for coastal erosion assessment is also mainly manual. Hurricanes can cause significant coastal erosion that causes the shorelines to retreat. This has adverse effects on coastal roads as well as the safety of local homes and businesses. It requires coordination with local law enforcement to fly over the designated areas before and after a storm. This, in many cases, can pose unexpectable safety risks. Additionally, the assessment is done using basic tools (video footage) which can be significantly improved to be more objective and quantitative.</p> <p>The unmanned aerial vehicles (UAVs), aka drones, have been adopted in the railroad industry in the United States to supplement their inspection efforts since 2015. In most UAV-based railway inspections, UAVs are controlled by an operator on ground. Therefore, the development of real-time UAV trajectory guidance associated with automated debris detection is necessary for rapid beyond-visual-line-of-sight (BVLOS) inspections in post-hurricane assessment and recovery.</p> <p>The proposed UAV-based inspection system, dubbed herein as “Storm-Drone”, comprises two major development thrusts: (i) optimal real-time autonomous guidance to enable autonomous operation of the UAV; and (ii) automated computer-vision software to locate track-blockage sections, estimate debris amounts and quantify shoreline erosion, using onboard camera(s). The development work will be conducted in two phases: the component-level development of the autonomous UAV-guidance unit and the computer-vision unit in Year 1; and the system-level development of integrated UAV prototype as an “all-into-one” system in Year 2.</p> <p>The FDOT mission is to provide a safe transportation system that ensures the mobility of people and goods, enhances economic prosperity and preserves the quality of our environment and communities. Storm-Drone directly impact FDOT mission critical objectives as it enables the timely opening of roads as well as the accurate assessment of shoreline retreat after a hurricane or a major storm.</p>		
Impact	<p>How shall the results impact practice? Consequences of not doing the research?</p> <p>The proposed UAV-based platform will enhance FDOT capability in post-disaster recovery in three main categories: (i) rapid survey of a hurricane-affected zone; (ii) post-disaster asset management by debris locations and volume for removal; and (iii) coastal erosion assessment to identify the best action to restore the shoreline in the affected areas.</p> <p>As the current state of practice continues, the assessment activities are not accurate as well as time consuming. Several areas are not reachable by the human crews to assess the damage. Additionally, it can pose safety hazard for human operators to venture in areas where there is a lot of debris. Moreover, shoreline erosion estimates are very subjective and rely on inaccurate measurements which can have long-term adverse effects on the coastal regions.</p>		
Affected Offices	<p>Identify any office and names of office personnel that will need to be involved in the scoping or conduct of the research, will be affected by implementation of the results, or will need to participate in the implementation process—including OTIT, if enterprise data/network software application will be a deliverable, and district staff, as appropriate, e.g., through statewide meetings. If the requesting office will not be the implementing office, please identify which office and names of specific personnel which will have to serve in that capacity—have they been involved?</p> <p>FDOT operations. Work will be mainly conducted and supervised by Brevard operations District 5. Testing ground will be provided at Brevard Operation.</p>		
Existing Work	Learning About and Using the Research in Progress (RiP) Database http://www.trb.org/main/blurbs/176215.aspx		

	<p>As a minimum, the Transportation Research International Documentation (TRID) and the Research in Progress (RIP) online databases should be reviewed by an expert in the research subject matter to assure research effort and resources shall not duplicate prior or ongoing work. TRID: https://trid.trb.org/Results RIP: https://rip.trb.org/</p> <p>Reviewing the Research in Progress (RIP) and the Transportation Research International Documentation (TRID) databases, there was no similar project proposed or published. However, in Europe using UAVs for shoreline erosion inspection has been proposed by several researchers for various locations in France, Germany and. Additionally, techniques to estimate ice.. are also investigated.</p> <p>For debris quantification, no research is currently ongoing that is related to the specific needs of FDOT. Using UAVs for inspection has been gaining popularity in various applications. In railroads, non-contact scour monitoring technique for railroad bridges has been proposed. The application was for inspecting railroad bridges over waterways. UAVs with sensing laser technologies are also proposed to assess the structural condition of simply supported spans. Additionally, UAVs are proposed to record railroad bridges displacements under traffic. Multi-rotor UAVs with camera and LIDAR is also proposed to detect track irregularities. UAVs have also been proposed for traffic monitoring testing UAVs in various traffic management scenarios, e.g. incident and traffic congestions.</p> <p>On the other hand, using UAVs for coastal erosion quantification has gained popularity in Europe and Australia. Several works address the coastal erosion problem due to the effect of rising sea levels using various computer vision techniques. However, there is no ongoing projects or published works that address the specific needs of the Florida coast as it is subjected to more abrupt changes during the hurricane season and requires faster deployment and assessment to respond to those changes.</p> <p>The proposed work integrates computer vision and beyond-visual-line-of-sight (BVLOS) UAV operation to produce the required information accurately, with minimum human intervention and in a timely manner to respond to</p>		
Keywords Used In Existing Work Search (Cannot leave blank)	Inspection, Hurricane recovery, Storm debris, Track blockage, Shoreline erosion, Drones, Computer vision, UAV, UAS.		
Related Contracts (Give contract numbers)	69A3551747132; Project 37; Project 39; Safety IDEA Project 32; DTRT13-G-UTC28, CAIT-UTC-NC8; 69A3551747119		
Funding Request	\$250,000	Anticipated Duration	2 years
Project Manager	Mo Hassan	Contracting Method	Direct contract with university
Urgency	1	Comments* (elaborate as appropriate on justification/impact comments to explain the urgency of the need . . . is a solution needed immediately, needed within a certain period of time or by a known or anticipated deadline, desired for enhancement, etc.)	
Implementability	1	Comments* (consider both the likelihood of implementation and the length of time and resources required to implement the results of the research.) Identify any prerequisites to, requirements for, or barriers to implementing the anticipated results of this research (e.g., new or change to existing specifications, development of production units of prototype device, legislative change); please indicate if multiple phases of work shall be required	
<p>Project Benefits (Succinct, complete explanation)</p> <p>Storm-Drone is a robust autonomous platform that promises to enhance post-hurricane damage assessment capabilities for FDOT operations. It overcomes the limitations of current practices and provides FDOT with accurate and timely information about road blockages and shoreline erosion that defines the subsequent repair and recovery efforts. The platform reduce the risk and the cost of post-hurricane assessments.</p>			

Project Benefits (Select all that apply and explain)	Quantifiable Benefits (units, dollars, etc...if applicable)	Methodology or Data Sources Used to Determine Quantifiable Benefits. If not applicable, please give justification of project benefits
○ Materials Enhancement	N/A	
○ Materials Savings	N/A	
○ Time Savings	Yes	Automating the process of debris quantification and estimation of damaged assets including coastal erosion/washout is a huge time saving
○ Lives Saved/Injuries Prevented	Yes	Responding after major disasters is always a dangerous endeavor. The use of drones as the first line of defense will for sure prevent lots of injuries.
○ Other (Explain)		

*Comments should explain and support urgency, financial benefit, and implementability scores